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COSTS AND EFFICIENCY IN FIELD PACKING WESTERN HEAD LETTUCE

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TABLE OF CONTENTS

Page

FOREWORD ii
COSTS AND EFFICIENCY IN FIELD PACKING WESTERN HEAD LETTUCE 1
FIELD-PACKING OPERATIONS AND OUTPUT RATES 2
  Operations Performed 2
  Production Standards 5
  Crew Organization and Output 6
FIELD-PACKING COSTS 9
  Direct Costs 12
  Fixed Costs 13
  Crew Costs Per Hour 14
COMPARISON OF COSTS PER CARTON WITH DIFFERENT METHODS 16
  Effect of Harvest Density 16
  Effect of the Piece-Rate Wage Plan 20
  Effect of the Length of Harvest Strip 20
COSTS IN OTHER DISTRICTS 21
COST REDUCTION POSSIBILITIES 25
  Choice of Present Methods 25
  Possible Improvements in Method and Equipment 26
  Description of Proposed Equipment 29
  Possibilities of Cost Reduction with the Proposed Method 30
APPENDIX TABLES 34

FOREWORD

Rapid changes in methods of harvesting and packing western head lettuce and in industry organization have resulted from the recent adoption of the vacuum-cooling process and a shift from house to field packing. With the change to field packing, several different types of equipment and work methods were developed. Considerable difference of opinion was observed in the industry as to which of these methods is the most economical.

This report presents data on the relative costs and efficiency of three methods of field packing commonly used in the 1953-54 season, namely, machine pack, trailer pack, and ground pack.

With crews paid on an hourly wage basis in the Salinas-Watsonville district, the machine-pack method was lowest in cost per carton at average rates of harvest per acre. The ground-pack method was the next lowest in cost, and the trailer-pack method was highest in cost per carton. Expressed in terms of savings per carlot, a shift from the trailer-pack to the machine-pack method in the Salinas-Watsonville district would, on the average, reduce costs by about $23 per carlot. A shift from the ground-pack to the machine-pack method would lower costs by about $17 per car. Such changes in the Salt River and Imperial districts would result in similar--although smaller--savings.

With a piece-rate wage plan, costs with a given method were found to be higher, except at low rates of harvest per acre, in all districts than with the hourly wage plan.

While the machine-pack method appears to be lowest in cost in most situations, improvements have been visualized that could increase its efficiency and lower costs still more. The potential saving compared to the present low-cost machine-pack method is estimated as approximately $30 per car.

The study shows that with a given work method the productivity of packing crews increases and costs per carton decrease as the rate of harvest per acre increases. This effect was considerably less noticeable with crews paid on a piece-rate basis as compared with those paid an hourly wage. Since relative costs with different methods change as harvest density changes, this factor must be considered in the cost comparisons.

These studies were made cooperatively by the Giannini Foundation of Agricultural Economics of the California Agricultural Experiment Station and the Agricultural Marketing Service, U. S. Department of Agriculture under authority of

SUMMARY

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the Research and Marketing Act of 1946. The work was performed as a part of Western Regional Research Project WM-14 relating to the marketing of western head lettuce.

COSTS AND EFFICIENCY IN FIELD PACKING WESTERN HEAD LETTUCE

by

Frank J. Smith,[1/] L. L. Sammet,[2/] and Robert V. Enochian[3/]

Until recently, shipping point operations for the western head lettuce industry were highly standardized with respect to the type of container used and the methods of harvesting and packing. Lettuce was harvested in the field, transported distances of up to 50 miles to a packing house, trimmed, placed in wooden crates between alternate layers of ice, and loaded into railroad cars for shipment.

In 1946, the principle of vacuum cooling was first applied to the precooling of lettuce. By eliminating the need for direct icing, this process made it feasible to substitute a corrugated paper carton for the wooden crate and to pack in the field rather than in a centralized packing house.

The principle of vacuum cooling is relatively simple. Packaged lettuce is placed in a sealed chamber where a vacuum is created. The reduction in pressure permits rapid evaporation of leaf surface moisture which reduces the internal temperature of the head. To obtain rapid, low temperature evaporation, the effect of the vacuum is supplemented by condensation of moisture on refrigerated coils located in the vacuum chamber. The desired shipping temperature--33° F.--is reached in 20 to 30 minutes, depending on the field heat in the lettuce at the time it is processed.

Adoption of the vacuum-cooling method was slow at first but increased rapidly when it proved feasible for use in conjunction with field packing in fibreboard containers. Field-packed shipments from the Salinas-Watsonville area rose from 20 per cent of total shipments in 1952 to 73 per cent in 1954. The changeover was even more spectacular in the winter lettuce areas, where, in some districts, up to 90 per cent of total shipments were field packed.

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Opinions among shippers varied widely with respect to the relative costs of the different methods of field packing. The objective of this report is to compare the costs and efficiency of the commonly used methods under different harvest conditions and to suggest changes with respect to crew organization, method, and equipment which might effectively reduce costs and increase efficiency. Shippers who usually have a good understanding of their own operation may use the results of these studies of alternative methods to improve the efficiency of their present practices.

FIELD-PACKING OPERATIONS AND OUTPUT RATES

While a number of variations in procedure and equipment were observed, the results in this report are limited to three methods commonly used in the 1953-54 season, namely, ground pack, machine pack, and trailer pack. Details of the operations performed in each of the three methods are given in the following section.

Operations Performed

The same basic operations are performed with each method. These include carton assembly, carton distribution, cutting and trimming, pickup, packing, carton closing, and loading. Details of how these operations are performed with the three methods and the number of men in each job category with typical crew organizations are shown in Figure 1.

The methods described in Figure 1 and illustrated in Figures 2, 3, and 4 differ primarily in the type of equipment, the number of men used in each job category, and the sequence and place of performing the various jobs. With the ground-pack method, all the jobs except carton assembly are performed on the ground. Crew size varies considerably with this method. The organization shown in the chart represents a size commonly observed during the study. With the trailer and machine methods, only the jobs of cutting and trimming and pickup are performed on the ground, and crew sizes are smaller than with the ground pack. The primary differences between the trailer- and machine-pack methods are that the latter has a much larger crew and the packing unit is self-propelled, while with the former, the packing unit must be pulled through the strip by a truck which also receives the packed cartons.

FIGURE 1

Operations and Crew Organization With Three Different Methods of Field Packing Lettuce

Operation	Method					
	Ground pack		Trailer pack		Machine pack	
	Job description	Number of men	Job description	Number of men	Job description	Number of men
Carton assembly	Carton truck precedes crew through harvest strip. Cartons are assembled and stitched on the truck and deposited on ground.	2	Cartons are assembled and stitched on forward part of trailer and placed on a carton slide to packers.	2	Cartons are assembled and stitched on a special platform on the machine and placed on a wheel conveyor to the packers.	2
Carton distribution	Cartons are picked up at truck side and distributed manually over the strip.	2	Not required.	0	Not required.	0
Cut and trim	Cutter trimmers cut, trim, and place lettuce on harvest bed; two beds per trimmer.	30	Same as with ground pack except that each man takes one bed.	8	Same as with trailer pack.	16
Pickup	Packers perform this operation.	0	A special crew of pickup men walking alongside the trailer transfers trimmed heads from the bed to tables on the trailer	4	A special crew of pickup men walking directly behind the machine transfers trimmed heads from the beds to tables on the machines.	8
Pack	Packers gather lettuce from the beds and place it in cartons. Packed cartons are left in furrow.	15	Packers riding the trailer transfer heads from packing table to cartons. Full cartons are placed on a roller conveyor to the closer.	4	Packers riding the machine transfer heads from packing table to cartons. Full cartons are placed on a power conveyor to the closer.	8
Close carton	Closers, using portable equipment, close and staple carton top.	4	Cartons are closed and stapled at the forward end of the trailer and placed on a conveyor to the truck which is pulling the unit.	2	Cartons are closed and stapled on a special platform on the machine and placed on a conveyor to a truck moving alongside the machine.	3
Load	Cartons are carried by hand from the packing furrows and loaded on a truck as it travels through the strip.	4	Cartons move by gravity conveyor to the truck and are stacked on pallets, 32 to the pallet, 320 to a truckload.	1	Same as with trailer.	2
Row boss	Supervise cutter-trimmers.	2	Same as with ground pack.	1	Same as with ground pack.	1
Supervise	Supervise over-all operation.	1	Same as with ground pack.	1/2[a]	Same as with ground pack.	1/2[a]

[a] Customary procedure is to have two machines or two trailers per field. The 1/2-man allocation indicates the division of time between the two units.

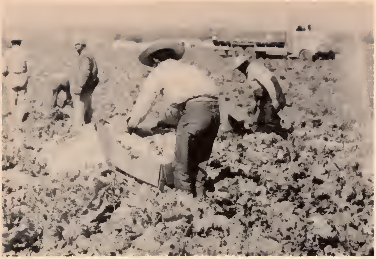

Figure 2. Field packing, ground pack method. Cutter-trimmers in left foreground; packers in center; in right background, a highway truck for transportation of packed cartons to precooler.

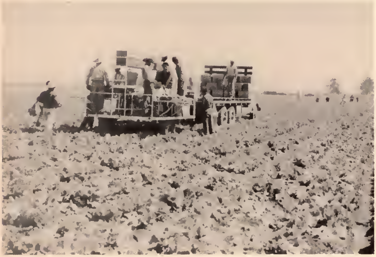

Figure 3. Field packing, trailer pack method. Truck — right foreground — draws trailer through harvest strip and receives packed cartons; pickup men on ground at sides of trailer. On trailer are the packers and carton closers; carton stitcher not shown. Cutter-trimmers in right background.

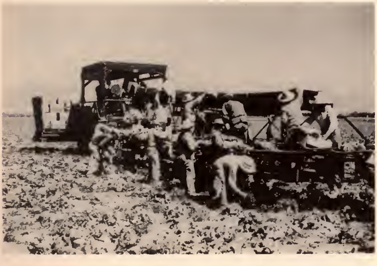

Figure 4. Field packing, machine pack method. Pickup men on ground behind machine; packers on machine; empty cartons assembled and full cartons closed on platform at left. Full cartons loaded on truck at far left.

Production Standards

The primary sources of data used in analyzing costs with the different methods of field packing are time and production studies of labor and equipment requirements made in the Salinas, Imperial, and Phoenix districts in 1953-54 and supplemental data from the accounting records of a sample of packing firms. These data were used to estimate net labor requirements for individual jobs.

Production standards typical of operation under relatively efficient conditions and with labor of average skills were derived from the estimates of net labor requirements by adding allowances for personal time, unavoidable delay, and turn-around time at the ends of each harvest strip. For example, the net productive time required to pack a carton with the machine-pack method, using an hourly rate wage plan, was estimated as 1.24 man-minutes. Allowing 20 per cent for personal time, unavoidable delay, and time lost in turning at the ends of the harvest strip, the gross time is 1.55 man-minutes per carton. This is equivalent to an output of 38.8 cartons per hour for a packer, and this rate is used in the analysis as the production standard for this job. When applied to and eight-man packer crew, this standard indicates a packer crew output of 310 cartons per hour. Some variation from this standard can be expected with regard to individual crews because of variations in the pace of different work crews, variations in the quality of supervision and quality of lettuce, differences between fields with respect to ground condition and layout, and differences in the firm's policy with respect to quality of pack. However, the standards so developed are considered good estimates of typical output rates.

The above procedure, with delay allowances appropriate to the particular job, was used in computing a production standard for each job in each method. Separate production standards were developed for work under piece-rate and hourly rate wage plans.

In making these studies, it was evident that many factors could influence output rates and costs from particular fields. Some of these factors, such as the method and equipment used, the wage plan, and the rate of harvest per acre, have easily measurable effects on productivity and are considered specifically in this report. Others, such as quality of lettuce, market price, the firm's policy with respect to quality of pack, ground condition, and the number of previous cuttings, have effects which could not be specifically measured but which are reflected to a large degree in the rate of harvest per acre.

Since the rate of harvest per acre has an important effect on productivity and costs, it is one of the principal considerations in the analysis. For convenience, rate of harvest is called "harvest density" and is defined as the number of cartons harvested per acre in a given cutting. Where the output rate of a particular job is affected by harvest density, this relationship is reflected in the production standard.

Crew Organization and Output

Hourly Rate Crews.--Production standards developed for individual jobs in the manner described above are the basis for the crew output data with different work methods and wage plans which follow. Production standards for the ground-pack, machine-pack, and trailer-pack methods using an hourly rate wage plan are summarized in Table 1. The output rates for individual jobs represent the potential production rates and these vary considerably from job to job. Crew output, however, is limited by the output rate on the bottleneck job since the packing process with all three methods is largely one of continuous flow from one job to another. This results in the full utilization of labor in the bottleneck job and, in the remaining jobs, idle time in excess of that included in the production standards. Further, since production rates on some jobs are affected by harvest density, actual output rates on other jobs are similarly affected.

Table 1 indicates that, with the ground-pack method, for example, at harvest densities of 100 and 150 cartons per acre, crew output is determined by the packer production standards of 265 and 292 cartons per hour. At a harvest density of 200 cartons per acre, the cutter-trimmers become the bottleneck and crew output is limited to 318 cartons per hour. For harvest densities above 200 cartons per acre, an additional carton distributor must be added if a maximum output of 348 cartons per hour--the rate for the cutter-trimmers--is to be attained. Table 1 indicates the standards for the carton closers with the ground-pack method to be less than for the other jobs at harvest densities greater than 150 cartons per acre. However, the cartons closers do not restrict crew output at the higher harvest densities, since this operation follows all the key jobs in the process and does not need to be perfectly harmonized with rates of output in other stages of the process.

With the machine method and harvest densities of 200 cartons per acre and less, output per crew hour is limited by the output attainable by the pickup crew.

TABLE 1

Production Standards and Number of Men Used in Each Job With Typical Crew Organization for Three Methods of Field Packing Two-Dozen-Size Cartons Using an Hourly Rate Wage Plan[a]

Job	Harvest density, cartons per acre	Method								
		Ground pack			Machine pack			Trailer pack		
		Standard output per man-hour	Crew size	Standard output per crew hour	Standard output per man-hour	Crew size	Standard output per crew hour	Standard output per man-hour	Crew size	Standard output per crew hour
		cartons		cartons	cartons		cartons	cartons		cartons
Cut and trim	100	9.1	30	273	13.6	16	218	13.6	8	109
	150	9.8		294	15.5		248	15.5		124
	200	10.6		318	16.7		267	16.7		134
	250	11.6		348	17.6		282	17.6		141
Pickup	100	(not required)			24.5	8	196	25.9	4	104
	150				29.5		236	30.8		123
	200				32.8		262	34.1		136
	250				35.2		282	36.4		145
Pack	100	17.7	15	265	38.8	8	310	38.8	4	155
	150	19.4		291						
	200	21.4		321						
	250	23.8		357						
Close carton										
Fold top		76.2	4	305[b]	184.0	2	368	226.4	1	226
Staple					363.0	1	363	242.9	1	243
Load flat-bed truck			4	400	222.0	2	444	178.0	1	178
Assemble carton										
Fold		429.0	1	429	429.0	1	429	(not required)		
Stitch		349.0	1	349	349.0	1	349	147.0	1	147
Distribute carton			2	320[c]	(not required)			(not required)		
Hauling cartons to precooler[d]	100		2	356		2	242		2	156
	150						272			178
	200						288			190
	250						300			194

(Continued on next page.)

Table 1 continued.

a/ Production standards are adjusted to allow for personal time, unavoidable delays, and unproductive turn time at the end of harvest strip. Calculations for the effect of turn time are based on strips 1,000 feet in length. For details see Appendix Tables A and C.

b/ Since the closing operation is preceded by all other major operations, it does not act as a bottleneck.

c/ For harvest densities of 200 cartons per acre and above, three carton distributors are required to attain an output of 348 cartons per hour--the output rate of the cutter-trimmers.

d/ For details of production standards for the hauling operation, see Appendix Table D.

With a harvest density of 250 cartons per acre, crew output is limited by both the pickup crew and the cutter-trimmers.

With the trailer-pack method, crew output at harvest densities of 100 and 150 cartons per acre is limited to 104 and 123 cartons per hour by the pickup men. For harvest densities of 200 and 250 cartons per acre, output is limited to 134 and 141 cartons per crew hour by the cutter-trimmers.

Piece-Rate Crews.--The results of a similar development of production standards for the three methods, using piece-rate wage plans, are summarized in Table 2.

Comparisons with Table 1 show that production rates with the piece-rate wage are substantially above those with the hourly rate plan. The piece-rate production standard for packers with the ground-pack method, for example, is 36.1 cartons per man-hour with a harvest density of 200 cartons per acre in contrast with a production standard of 21.4 cartons for packers under an hourly rate wage plan. Similar comparisons can be made for other jobs and with other methods.

The range of densities observed for the ground-pack method using this wage plan were too narrow to obtain significant relationships between harvest density and rate of output. The standards for all jobs, therefore, are presented at an average harvest density of 200 cartons per acre.

FIELD-PACKING COSTS

The production standards data given above is the principal basis for the estimates of field-packing costs which follow. The cost components considered are defined below. They include direct labor and field supervision, operating and fixed costs of equipment, and the costs of precooling and packaging materials.1/

Administrative costs and general expenses are not considered, but the costs of these items would not vary significantly with the different field-packing methods studied.

1/ For a more complete breakdown of these costs, see Appendix Tables E through H.

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TABLE 2

Production Standards and Number of Men Used in Each Job With Typical Crew Organization for Three Methods of Field Packing Two-Dozen Size Cartons Using a Piece-Rate Wage Plan[a]

Job	Harvest density, cartons per acre	Method								
		Ground pack			Machine pack			Trailer pack		
		Standard output per man-hour	Crew size	Standard output per crew hour	Standard output per man-hour	Crew size	Standard output per crew hour	Standard output per man-hour	Crew size	Standard output per crew hour
		cartons		cartons	cartons		cartons	cartons		cartons
Cut and trim	100	16.9	30	507	17.9	16	286	17.9	8	143
	150				21.9		350	21.9		175
	200				24.6		394	24.6		197
	250				26.7		427	26.7		214
Bunch heads									2	--[b]
Pickup	100	(not required)			38.6	8	309	38.6	4	154
	150				46.3		370	46.3		185
	200				51.4		411	51.4		206
	250				55.0		440	55.0		229
Pack	100	36.1	14	504	47.0	8	376	47.0	4	188
	150									
	200									
	250									
Close carton										
Fold top					282	2	564	289.0	1	289
Staple		92.0	6	540	472	1	472	262.0	1	262
Load flat-bed truck			4	568	270	2	540	394.0	1	394
Assemble carton										
Fold		550.0	1	550	550	1	550	(not required)		
Stitch		550.0	1	550	550	1	550	223.0	1	223
Distribute carton		248.0	2	496	(not required)			(not required)		
Hauling cartons to precooler[c]	100		2.5	510		2	302		2	198
	150						334			220
	200						352			244
	250						352			256

(Continued on next page.)

Table 2 continued.

a/ Production standards are adjusted to allow for personal time, unavoidable delays, and unproductive turn time at the end of harvest strip. Calculations for the effect of turn time are based on strips 1,000 feet in length. For details see Appendix Tables B and C.

b/ No production standards were computed for the bunching operation.

c/ For details of production standards for the hauling operation, see Appendix Table D.

Direct Costs

Harvesting and Packing Labor.--Harvesting and packing labor costs include the costs of cutting and trimming, packing, carton assembly, carton distribution, carton closing, and loading highway trucks. As previously noted, two methods of payment were observed for jobs in this category--hourly rate and piece rate.

With the hourly rate plan, harvesting and packing labor costs per crew hour for each method were obtained by multiplying the number of men in each job category by the applicable wage rate and totaling for the entire crew (see Appendix Table E). Labor costs were calculated separately for the Salinas-Watsonville and winter lettuce areas. The wage rates used in these calculations were typical for each district. Eleven per cent was added to the direct wage cost of Mexican National labor to cover camp costs. Five per cent was added to the direct wage cost for local employees to cover social security and workmen's compensation taxes.

The piece-rate plan involves the payment of a total piece rate per carton to be divided among various harvesting and packing labor categories. Total costs per crew hour are obtained by multiplying total output per crew hour by the total piece rate.

Under the piece-rate wage plan, each worker is guaranteed a minimum hourly wage corresponding to that paid under the hourly wage plan. However, for the range of output rates observed for piece-rate crews in this study, earnings under the piece-rate plan exceed the hourly minimum.

Equipment Operating Labor.--Equipment operating labor costs include the wages of drivers of field-packing machines, field trucks (trucks on which cartons are assembled), and highway trucks. The labor costs of packing machine and field truck drivers are based on the field operating time plus a 12.5-per cent allowance for highway travel to and from the field. The labor costs of highway truck drivers include allowances for waiting and loading time in the field plus allowances for round-trip travel time from the field to the precooler and waiting and unloading time at the precooler. (For details, see Appendix Tables D and H.) The average round-trip distance observed at the time of the study was 20 miles, and the travel time allowance is based on that figure. For round-trip distances other than 20 miles, approriate adjustment in the costs of equipment operating labor would be required. Equipment drivers were paid on an hourly basis regardless of the wage plan use for other members of the crew.

Labor costs per hour for drivers working with hourly rate crews were the same as with piece-rate crews except with the ground-pack method. With the ground-pack, piece-rate method, the accelerated rate of output requires an additional highway truck and a higher hourly cost for trucking to facilitate delivery of packed cartons to the precooler.

Fuel, Repairs, and Tires.--This category includes the costs of such items as gasoline, oil, tires, equipment, repair, and miscellaneous expenses involved in operating field-packing machinery and field and highway trucks (see Appendix Tables G and H for details). These costs were computed on an hourly basis and were derived from data obtained from the industry, previous studies of field-to-plant transportation operations, and estimates of the costs of trucking farm products prepared by the California Public Utilities Commission.[1]

Salaried Field Supervision.--These costs include only the salary expense of direct field supervision of harvesting and packing operations. The salary expense of those concerned with the firm's over-all operations (for example, the general manager or general superintendent) is not included in this category.

Although considerable variation in method of operation, crew size, and output was observed, the amount of salaried supervision did not seem related to these variables. The practice commonly observed was to have one salaried supervisor in each field being harvested. This ordinarily meant that one man supervised one ground-packing crew, two machine crews, or two trailer crews. This organization in regard to supervision is reflected in the cost estimates. (For details, see Appendix Table F.)

Fixed Costs

The fixed costs for equipment include insurance, license fees, interest on investment, taxes, and depreciation. Depreciation charges were based on an eight-year use life for all equipment except hand tools used in ground packing; charges for ground-packing equipment were based on a five-year use life. Cost rates for insurance, taxes, and interest on investment were derived from data

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[1] California Public Utilities Commission, Transportation Department, Engineering Division, Report on the Cost of Transporting Fresh Fruits and Vegetables by Motor Vehicle Equipment Within California, Excluding Movements to Canneries and Processing Plants (Los Angeles: 1952), Case No. 4808.

obtained from the industry and from previous studies of packing operations. Annual charges, computed on a percentage basis, are based on 1953 replacement costs for equipment. (For details on fixed costs, see Appendix Tables G and H.)

Annual fixed charges for equipment were reduced to costs per field hour on the basis of a 1,280-hour season (32 weeks per year, 40 hours per week). This length of season is applicable to the Salinas-Watsonville area. The operating season in the winter lettuce areas is shorter and equipment costs per hour will be higher unless alternative use is found for the equipment during other seasons of the year. Similarly, a longer use period for firms operating in both areas would reduce equipment costs per hour although the rate of reduction for use above 1,280 hours per season would be small.

Crew Costs Per Hour

A summary of costs per hour for the cost components described above is given in Table 3 for the three packing methods studied and for the hourly and piece-rate wage plans. Labor costs per field hour are based on the crew size specified with each method in Tables 1 and 2. Equipment costs are related to the hourly output of these crews and to the quantities and types of equipment required with each method. The details of these calculations are given in the Appendix.

Since crew size can be varied, particularly with the ground-pack method, the costs per crew hour given in Table 3 have significance only with respect to the crew organization from which they are derived. However, the organization and size of crews on which these estimates are based were commonly observed and represent relatively efficient combinations of crew and equipment. In relation to the hourly output rates of the particular crews specified, these costs provide a good basis for computing unit costs per carton for comparisons of efficiency with the different methods and wage plans.

In the cost comparisons which follow, crew organizations and costs per field hour with each method are fixed. With costs per crew hour constant, unit costs per carton then vary as rate of crew output changes with variation in harvest density.

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TABLE 3

Labor, Equipment, and Supervision Cost Per Crew Hour Based on Typical Crew Organization[a] With Three Methods of Field Packing Salinas-Watsonville District, 1953-54

Item	Method		
	Ground pack	Machine pack	Trailer pack
	cost per field hour--dollars		
Hourly rate crews			
Labor:			
Harvesting and packing	58.30	39.40	21.92
Equipment operating	5.41	5.41	3.47
Subtotal	63.71	44.81	25.39
Equipment:			
Fuel, repair, and tires	4.12	4.50	2.82
Fixed costs	4.11	5.04	3.12
Subtotal	8.23	9.54	5.94
Supervision	3.28	1.64	1.64
Total	75.22	55.99	32.97
	minimum cost per field hour--dollars		
Piece-rate crews			
Labor:			
Harvesting and packing[b]	59.96	41.04	23.86
Equipment operating	6.28	5.41	3.47
Subtotal	66.24	46.45	27.33
Equipment:			
Fuel, repair, and tires	4.78	4.50	2.82
Fixed costs	4.75	5.04	3.12
Subtotal	9.53	9.54	5.94
Supervision	3.28	1.64	1.64
Total	79.05	57.63	34.91

[a] For crew organizations for the three methods, see Tables 1 and 2.

[b] The total harvesting and packing labor costs shown here are based on the guaranteed minimum hourly wage. For the range of output rates observed for piece-rate crews, however, earnings under the piece-rate exceed the hourly minimum. Therefore, for usual conditions, harvesting and packing labor costs per crew hour will be higher than those shown.

COMPARISON OF COSTS PER CARTON WITH DIFFERENT METHODS

From the data presented in Tables 1, 2, and 3 average costs per carton for field labor and equipment can be calculated by dividing crew costs per hour by the appropriate production rate per crew hour. Where piece-rate wages apply, the average cost per carton may be estimated by similarly computing unit operating labor costs, unit equipment operating costs, unit fixed costs, and unit supervisory costs and adding these costs to the labor piece rate per carton. To obtain the total costs per carton, the costs of carton and staples and the costs of precooling and carloading must be added. The results of such calculations for the three methods and the two wage plans described above are given in Table 4 and illustrated in Figure 5.

Effect of Harvest Density

The estimated unit costs indicate that, with the hourly rate wage plan, output per packer hour increases and unit costs decrease substantially with all three packing methods as harvest **density** varies from 100 cartons to 250 cartons per acre. Through this range with the machine method, for example, output per packer hour increases from approximately 25 to 35 cartons (40 per cent), and total costs per carton decrease from 70.6 cents to 61.9 cents (12.3 per cent). If only labor and equipment costs are considered (total cost less package materials, precooling, and loading), the decrease in costs through the range of harvest densities is 30.4 per cent.

Since field labor and equipment costs per carton vary with harvest density, this factor must be considered in making cost comparisons with different methods. At a harvest density of 200 cartons per acre (approximately the average for the industry during the period of the field studies), the hourly rate machine-pack method had the lowest unit costs--63.3 cents per carton. This is 3.3 cents per carton less than with the trailer-pack method and 2.3 cents per carton less than with the ground-pack method. About the same relationships apply at the high harvest density of 250 cartons per acre. With a low harvest density of only 100 cartons per acre, however, unit costs are lowest with the ground-pack method--70.4 cents per carton. This is 0.2 cent per carton lower than with the machine-pack method and 3.3 cents per carton less than with the trailer-pack method.

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TABLE 4

The Effect of Work Method, Wage Plan, and Harvest Density on Costs of Labor and Equipment
for Field Packing Two-Dozen-Size Cartons of Lettuce in the
Salinas-Watsonville Area, California, in 1953-54
(Excluding General Overhead Costs)

Method	Harvest density, cartons per acre[a]	Output, cartons per packer hour[b]	Labor and equipment						Packaging and service		
			Harvesting and packing labor	Equipment operating labor	Fuel, repairs, and tires	Fixed costs of equipment	Supervision	Subtotal	Cartons and staples	Precooling and loading	Total
			cents per carton								
HOURLY RATE:											
Ground pack	100	17.7	22.0	2.0	1.6	1.6	1.2	28.4	27.0	15.0	70.4
	150	19.4	20.0	1.9	1.4	1.4	1.1	25.8			67.8
	200	21.2	18.3	1.7	1.3	1.3	1.0	23.6			65.6
	250	23.2	17.0	1.6	1.2	1.2	.9	21.9			63.9
Machine pack	100	24.5	20.1	2.8	2.3	2.6	.8	28.6	27.0	15.0	70.6
	150	29.5	16.7	2.3	1.9	2.1	.7	23.7			65.7
	200	32.8	15.0	2.1	1.7	1.9	.6	21.3			63.3
	250	35.3	14.0	1.9	1.6	1.8	.6	19.9			61.9
Trailer pack	100	26.0	21.1	3.3	2.7	3.0	1.6	31.7	27.0	15.0	73.7
	150	30.8	17.8	2.8	2.3	2.5	1.3	26.7			68.7
	200	33.5	16.4	2.6	2.1	2.3	1.2	24.6			66.6
	250	35.3	15.5	2.5	2.0	2.2	1.2	23.4			65.4
PIECE RATE:											
Ground pack	200	35.4	20.8[c]	1.3	1.0	1.0	.7	24.8	27.0	15.0	66.8
Machine pack	100	35.7	19.8[c]	1.9	1.6	1.8	.6	25.7	27.0	15.0	67.7
	150	41.8		1.6	1.3	1.5	.5	24.7			66.7
	200	44.0		1.5	1.3	1.4	.5	24.5			66.5
	250	44.0		1.5	1.3	1.4	.5	24.5			66.5
Trailer pack	100	35.8	20.2[c]	2.4	2.0	2.2	1.1	27.9	27.0	15.0	69.9
	150	43.8		2.0	1.6	1.8	.9	26.5			68.5
	200	49.2		1.8	1.4	1.6	.8	25.8			67.8
	250	53.5		1.6	1.3	1.5	.8	25.4			67.4

(Continued on next page.)

Table 4 continued.

a/ Harvest density is defined as the number of cartons harvested per acre in a given cutting.

b/ Output per packer hour is obtained by dividing crew output by the number of packers.

c/ The piece rates paid harvesting and packing labor did not vary with harvest density.

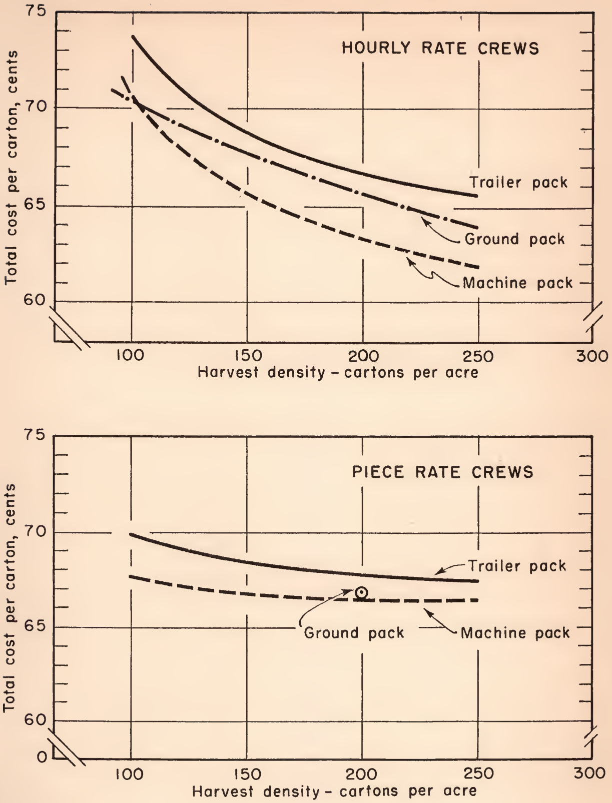

FIGURE 5. The Effect of Work Method, Wage Plan, and Harvest Density on Costs of Field Packing, Precooling, and Loading Two-Dozen-Size Cartons of Lettuce in the Salinas-Watsonville Area, California, in 1953-54 (Excluding General Overhead Costs)

The principal saving in costs with the machine method relative to the ground method occurs in the harvesting and packing labor. This advantage is partly offset by additional costs of operating labor, repairs, and fuel, and fixed charges for equipment. With the trailer-pack method, harvesting and packing labor costs are still low relative to the ground-pack method. However, because of high equipment costs in relation to the rate of crew output, total unit costs with the trailer method are high relative to other methods.

Effect of the Piece-Rate Wage Plan

The results of studies of packing under the piece-rate wage plan shown in Table 4 and Figure 5 indicate total unit costs to be 66.8 cents for the ground-pack method, 66.5 cents for the machine-pack method, and 67.8 cents for the trailer-pack method at a harvest density of 200 cartons per acre. Relatively little variation in unit costs due to changes in harvest density is shown for any of the methods. The lack of variation in costs with respect to method or harvest density is due largely to the fact that all the harvesting and packing labor costs with the piece-rate plan were established at fixed rates per carton, which did not vary with harvest density, and were subject to only minor variation among the various work methods. With the piece-rate wage plan, therefore, the main sources of change in unit costs, as harvest density varies, are the fixed charges and operating labor for equipment, and these effects are not large. When the two wage plans are compared, costs with the hourly rate plan are lower with all methods, except at low harvest densities.

Effect of Length of Harvest Strip

The results presented in Table 4 are based on harvest strips 1,000 feet long, approximately the average for all fields studied. Considerable variation in length of strip was observed. As the strip becomes shorter, a higher proportion of crew time per strip is devoted to turning around so that crew productivity is reduced and costs rise.

The effect of length of strip is not significant with ground-pack crews. With machine crews, however, this effect is important, especially at lower harvest densities. At a harvest density of 100 cartons per acre, with a 500-foot strip, and a 5-minute allowance for turn-around time, labor and equipment costs

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(total costs less packaging materials and precooling) are 22 per cent higher than they are with a strip 1,000 feet long. As harvest density increases, this effect decreases rapidly, and at a harvest density of 200 cartons per acre, the difference in costs is only 6 per cent. At a harvest density of 250 cartons per acre, the difference is 4 per cent.

With the trailer-pack method at a harvest density of 100 cartons per acre on a 500-foot strip and with a 3-minute allowance for turn-around time, labor and equipment costs are 6 per cent higher than they are with a 1,000-foot strip. With a harvest density of 200 cartons per acre, the difference is 4 per cent and at a harvest density of 250 cartons, 3 per cent.

Field-packing machines, developed since these studies have been made, are reported to have greatly reduced the amount of time required in turning at the end of harvest strips. Such improvements would reduce the effect of length of strip.

COSTS IN OTHER DISTRICTS

The cost data shown in Table 4 and illustrated in Figure 5 are based on conditions typical of the Salinas-Watsonville district in California. In the winter lettuce districts, hourly wage rates for harvesting and packing labor are about 20 per cent lower, and the packing season is shorter. Table 5 and Figure 6 show the results of adjusting the cost calculations for the Salinas-Watsonville district to wage levels and length of season applicable to the winter lettuce areas.

Equipment costs are based on a 720-hour operating season rather than the 1,280-hour season used in the computations for the Salinas-Watsonville district (see Appendix Tables G and H for details). Piece-rate crews and certain jobs with hourly rate crews received the same rate paid for comparable work in the Salinas-Watsonville district and no adjustment was required. Necessary adjustments in wage rates on other jobs were made in computing labor costs. (The wage rates used are shown in footnote d, Table 5.

The shorter season in the winter areas tends to make the unit fixed costs of equipment high relative to the Salinas-Watsonville district, while lower wage rates, with hourly wage crews, tend to make harvesting and packing labor costs lower. With piece-rate crews, harvesting and packing labor costs are the same in both areas.

TABLE 5

The Effect of Work Method, Wage Plan, and Harvest Density on Cost of Labor and Equipment for Field Packing Two-Dozen-Size Cartons of Lettuce in the El Centro, California-Phoenix, Arizona Areas in 1953-54
(Excluding General Overhead Costs)

			Labor and equipment						Packaging and service		
Method[a]	Harvest density, cartons per acre[b]	Output, cartons per packer hour[c]	Harvesting and packing labor	Equipment operating labor	Fuel, repairs, and tires	Fixed costs of equipment	Supervision	Subtotal	Cartons and staples	Pre-cooling and loading	Total
			cents per carton								
HOURLY RATE:[d]											
Ground pack	100	17.7	17.8	2.0	1.6	2.8	1.2	25.4	27.0	15.0	67.4
	150	19.4	16.2	1.9	1.4	2.5	1.1	23.1			65.1
	200	21.2	14.8	1.7	1.3	2.3	1.0	21.1			63.1
	250	23.2	13.7	1.6	1.2	2.1	.9	19.5			61.5
Machine pack	100	25.9	16.8	2.8	2.3	4.6	.8	27.3	27.0	15.0	69.3
	150	30.8	14.0	2.3	1.9	3.8	.7	22.7			64.7
	200	33.4	12.6	2.1	1.7	3.4	.6	20.4			62.4
	250	35.3	11.7	1.9	1.6	3.2	.6	19.0			61.0
Trailer pack	100	27.0	17.5	3.3	2.7	5.3	1.6	30.4	27.0	15.0	72.4
	150	31.0	14.8	2.8	2.3	4.5	1.3	25.7			67.7
	200	33.5	13.6	2.6	2.1	4.1	1.2	23.6			65.6
	250	35.3	12.9	2.5	2.0	3.9	1.2	22.5			64.5
PIECE RATE:[e]											
Ground pack	200	35.4	20.8	1.1	.8	1.7	.7	25.1	27.0	15.0	67.1
Machine pack	100	35.7	19.8	1.9	1.6	3.1	.6	27.0	27.0	15.0	69.0
	150	41.8		1.6	1.3	2.7	.5	25.9			67.9
	200	44.0		1.5	1.3	2.5	.5	25.6			67.6
	250	44.0		1.5	1.3	2.5	.5	25.6			67.6
Trailer pack	100	35.8	20.2	2.4	2.0	3.9	1.1	29.6	27.0	15.0	71.6
	150	43.8		2.0	1.6	3.2	.9	27.9			69.9
	200	49.2		1.8	1.4	2.8	.8	27.0			69.0
	250	53.5		1.6	1.3	2.6	.8	26.5			68.5

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Table 5 continued.

a/ Crew organizations and output rates are the same as shown for the Salinas-Watsonville district in Tables 1 and 2.

b/ Harvest density is defined as the number of cartons harvested per acre in a given cutting.

c/ Output per packer hour is obtained by dividing crew output by the number of packers.

d/ The following are the wages paid hourly rate crews in the winter lettuce districts: Row boss--$0.90; cutter-trimmers, packers, carton distributors, carton closers (ground pack), empty carton folders, packed carton folders (machine pack), loaders--$0.70; and carton stitchers, carton closers (machine pack)--$1.575.

e/ Piece-rate crews are paid on the same basis as in the Salinas-Watsonville district.

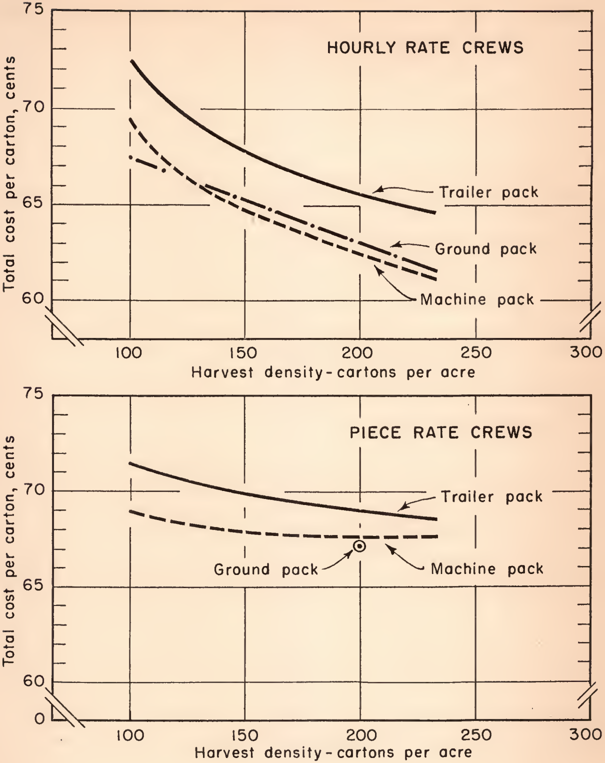

FIGURE 6. The Effect of Work Method, Wage Plan, and Harvest Density on Costs of Field Packing, Precooling, and Loading Two-Dozen-Size Cartons of Lettuce in the El Centro, California-Phoenix, Arizona, Areas in 1953-54 (Excluding General Overhead Costs)

The cost data for the winter lettuce areas (Table 5) show that with hourly rate crews and an average harvest density of 200 cartons per acre, the costs per carton in the winter lettuce areas range from 1.0 cent to 2.5 cents less than in the Salinas-Watsonville area. On the other hand, costs with piece-rate crews range from 0.3 cent to 1.2 cents per carton more than in the Salinas-Watsonville area since the fixed costs of equipment per field hour are higher in the winter districts while labor and other costs are the same.

Table 5 shows that, as in the Salinas-Watsonville district, the hourly rate machine method again has the lowest cost--62.4 cents per carton--at a harvest density of 200 cartons per acre. This is 3.2 cents less than the hourly rate trailer method but only 0.7 cent less than the hourly rate ground-pack method. At a high harvest density of 250 cartons per acre, these differences are 3.5 cents and 0.5 cent, respectively. At a low harvest density of 100 cartons per acre, the hourly rate ground-pack method has the lowest cost per carton--67.4 cents. This is 1.9 cents less than the machine-pack hourly method and 5.0 cents less than the trailer-pack method.

With piece-rate crews, total unit costs at a harvest density of 200 cartons per acre are 67.1 cents for the ground-pack method, 67.6 cents for the machine-pack method, and 69.0 cents for the trailer method. The variation in unit costs with respect to method and harvest density is small because, as in the Salinas-Watsonville district, harvesting and packing labor was paid at a fixed rate per carton which was subject to only minor variation among the methods.

COST REDUCTION POSSIBILITIES

Two possibilities for reducing the costs of field packing western head lettuce are presented in the following sections. One involves the selection of the most economical method, in regard to operating conditions, from the several methods now being employed; the second involves the improvement of methods and equipment now being used through redesign of equipment and reorganization of the crew.

Choice of Present Methods

With hourly rate crews in the Salinas-Watsonville district, the machine-pack method is lowest in cost in the range of harvest densities of slightly

above 100 to 250 cartons per acre (Figure 5). At a low harvest density of 100 cartons per acre, the ground-pack method is the lowest in cost per carton. The trailer-pack method is the high-cost method at all levels of density. Expressed on a carlot basis, the saving with the machine method over the ground-pack method is $17 per carlot (640 cartons) when the harvest density averages 200 cartons per acre. A similar comparison with the trailer method indicates savings with the machine method of $23 per carlot. Therefore, a change to the machine method by shippers using either the ground- or trailer-pack method would result in sizable cost reductions in the Salinas-Watsonville district.

In the winter lettuce districts, the machine method, with hourly rate crews, again has the lowest costs for harvest densities of approximately 125 cartons per acre or greater, and the trailer-pack method has the highest costs at all densities (see Figure 6). At an average harvest density of 200 cartons per acre, the saving with the machine method amounts to roughly $4.50 per car when compared with the ground-pack method and $20.50 per car when compared with the trailer-pack method.

Except at low harvest densities, costs per carton with a piece-rate wage plan were higher with all methods than with an hourly rate wage plan.

Possible Improvements in Method and Equipment

The results of this study indicate a cost advantage for the machine method of field packing. Analysis of the present machine-pack method indicates, however, that improved machine design and reorganization of the crew may increase efficiency and lower costs still more. The possibilities for improvement stem largely from reducing the effects of variations in harvest density and the elimination of the pickup operation.

Three characteristics of the field-packing operations make variations in output rates of the cutter-trimmers and pickup jobs an important factor in overall crew efficiency. First, during the field-harvesting and packing process, variation in harvest density is continuous. It occurs between different fields, between different harvest strips in a given field, and within a given strip. Second, the continuous nature of variations in harvest density makes it feasible to adjust crew organization to it only when changes in the general level of harvest density prevail for a period of several days. Third, with a fixed crew organization, variation in rate of flow of lettuce from the cutter-trimmers and

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and pickup groups means that the remaining workers--whose potential output is not affected by variations in harvest density--rarely are in "harmony" with these two groups. Most of the time, the flow of lettuce is either too small to keep other workers fully occupied, or certain workers are overloaded.

The above difficulties in harmonizing the efforts of the several groups of workers are magnified by conditions of field layout and operating procedures now followed with the machine-pack method. This involves fixed crew assignments whereby the output of two cutter-trimmers is channeled through one pickup man to a single packer. With this arrangement, variations in harvest density between planting beds in the harvest strip have an important effect. In an extreme case, for example, harvest density may be high for one pickup man and low for all others. Since the forward speed of the machine is governed by the high density row, the remaining pickup men are underutilized and crew efficiency is reduced.

Some possibilities of improving crew integration and performance are developed in Table 6. The data apply to an average harvest density of 200 cartons per acre. Two measures of output rate, "potential" and "realized" output per crew hour, are shown in Table 6. The potential output rates per crew hour for each job were obtained by multiplying the production standards per man-hour (Table 1) by the number of workers per job. With the present machine-pack method, for example, Table 6 indicates a potential crew output for the cutter-trimmer job of 267 cartons per hour. For the remaining jobs with this method, crew output rates range from 262 cartons per hour for the pickup crew to 444 cartons for the loading crew.

Since the process is essentially one of continuous flow between jobs, the over-all crew output is determined by the output rate on the "bottleneck" job. With the present machine-pack method, this is the pickup operation at 262 cartons per hour, and this rate is the realized rate in all other job categories. From Table 6, it is clear that actual performance on jobs for which the potential rate exceeds the realized rate involves a higher proportion of nonproductive time than is provided by the allowances used in estimating potential output per man-hour. On some jobs, these actual nonproductive time percentages are quite high, ranging from 10 per cent for the cutter-trimmer job to 47 per cent for the loading job.

One type of possible improvement in the existing machine-pack method is evident in Table 6. This is better integration of the crew so as to reduce the

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TABLE 6

Operations Performed and Labor Utilization Data for Present and Proposed Machine-Pack Methods of Field Packing Head Lettuce (Harvest Density, 200 Cartons Per Acre), California-Arizona, 1953-54

	Machine-pack method									
	Present					Proposed				
	Number of men	Output, cartons per crew hour		Per cent delay		Number of men	Output, cartons per crew hour		Per cent delay	
Operations		Potential	Realized	Standard	Actual		Potential	Realized	Standard	Actual
Cut and trim	16	267	262	8	10	18	301	301	8	8
Pickup	8	262	262	12	12	(not required)				
Pack	8	310	262	20	33	8	310	301	20	23
Close carton										
Fold top	2	368	262	10	39	2	358	301	10	31
Staple	1	363	262	10	38	1	363	301	10	30
Assemble cartons										
Fold	1	429	262	10	45	1	429	301	10	37
Stitch	1	349	262	10	32	1	349	301	10	23
Load	2	444	262	10	47	2	444	301	10	40
Haul	2	288	262	--	--	2	310	301	--	--

nonproductive time on certain jobs. Three other possibilities not evident in Table 6 are: (1) the elimination of the pickup job; (2) the more even distribution of the harvested lettuce among the packers; and (3) the provision of a reserve supply of lettuce so as to maintain a steady supply to all packers despite variations in harvest density over the strip.

Assuming that the present eight-man packer unit is retained, the following changes in equipment design and crew organization would be required to achieve the above objectives: (1) increased capacity in the cutter-trimmer crew to a level more nearly equal to the potential output rate of the packers; (2) provision of a conveyor system that would carry trimmed heads directly from the cutter-trimmers to the packers and that would perform this work without significant damage to the lettuce and without appreciable decrease in the cutter-trimmer output rates per man-hour; and (3) provision of a small reserve storage capacity either on the conveyor or at the individual packing stations.

The effects on crew organization and output rates that would follow the changes described above are shown by comparison of the output data given for the proposed method in Table 6 with that for the existing method. These effects include: elimination of 8 pickup men; increase in the number of cutter-trimmers from 16 to 18 men; adjustment of realized output per crew hour for all jobs from 262 cartons per hour to 301 (the capacity rate for the cutter-trimmers); and reduction in the percentage of actual idle time. For example, nonproductive time for packers would be reduced from 33 to 23 per cent, for loaders, from 47 to 40 per cent, and similarly for other jobs.

Description of Proposed Equipment

While several machines have been visualized that would incorporate the features presumed necessary to attain the above objectives, the description that follows is limited to one machine. It involves a conveyor system integrated with a truck-mounted packing unit.

Conveyor System.--A main conveyor, similar in concept and over-all dimension to field conveyors used in harvest for house pack, would extend at right angles from the packing unit. It would cover a harvest strip 14 beds wide. Projecting from the front of the conveyor and parallel to the harvest beds would be seven stub conveyors (approximately 6 feet in length) and from the rear six stub conveyors. Fourteen cutter-trimmers, each man in a furrow, would

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work in front of the main conveyor, and four would work behind it. Each man working in front would cut and trim lettuce from the rows adjacent to each side of his furrow. Trimmed heads would be placed on the nearest stub conveyor which would carry them to the main conveyor for transport to the packing unit. Those men working behind the conveyor would vary their positions to assist slow workers or men working in beds of relatively high harvest density. Since it is customary to remove only the outside wrapper leaves in the field-packing operation, it is presumed that a carefully designed conveyor system could deliver the lettuce to the packing unit without significant damage.

Packing Unit.--The packing unit to which the conveyor is attached would be mounted on a special wide-tread truck. One of its components would be a rotating tub around which eight packers would be stationed. Lettuce from the cutter-trimmers would be deposited in the tub by the conveyor system described above. The bottom of the tub would have an inverted cone shape so that the lettuce deposited would roll to the outside for easy access by the packers. The tub would provide enough storage space to level out the effects of variations in flow of lettuce from the cutter-trimmers. When the rate of flow is large, lettuce would be accumulated in the tub. When the flow of lettuce is small, packers could draw on the accumulated supply.

Other components on the machine are the carton-assembly and carton-closing units which would be similar in all respects to those on present machines.

Possibilities of Cost Reduction With the Proposed Method

It must be emphasized that the machine described in the previous section is purely hypothetical. However, since many of its characteristics would be similar to the present types of equipment, its construction appears feasible and should not result in initial cost much different from that of the present machine. Hence, in the discussion that follows, it will be assumed that the current replacement cost of both machines is the same. Further, it is assumed that that operating costs (fuel, repair, and tires) and operating labor costs (highway truck drivers and machine drivers) are also the same.

With the above assumptions, costs with the present machine-pack method and the proposed method, described in Table 6, are presented in Table 7 and illustrated in Figure 7. The total costs per field hour from which the unit costs in Table 7 are derived are shown in the footnotes. The difference in harvesting

TABLE 7

The Effect of Work Method and Harvest Density on Cost of Labor and Equipment for Field Packing Two-Dozen-Size Cartons of Lettuce (Excluding General Overhead Costs)[a]

				Equipment							
	Harvest density	Output, cartons per crew hour	Harvesting and packing labor	Operating labor	Fuel and repair	Fixed cost	Supervision	Subtotal	Cartons and staples	Precool	Total
			cents								
Present method[b]	100	196	20.1	2.8	2.3	2.6	0.8	28.6	27.0	15.0	70.6
	150	236	16.7	2.3	1.9	2.1	0.7	23.7			65.7
	200	262	15.0	2.1	1.7	1.9	0.6	21.3			63.3
	250	282	14.0	1.9	1.6	1.8	0.6	19.9			61.9
Proposed method[c]	100	245	13.7	2.2	1.8	2.0	0.7	20.4	27.0	15.0	62.4
	150	279	12.0	1.9	1.6	1.8	0.6	17.9			59.9
	200	301	11.1	1.8	1.5	1.7	0.5	16.6			58.6
	250	310	10.8	1.7	1.4	1.6	0.5	16.0			58.0

[a] Based on prices of labor and equipment appropriate to the Salinas-Watsonville district.

[b] Costs per crew hour for various categories are as follows: harvesting and packing labor, $39.40; equipment operating labor, $5.41; fuel, repair, and tires, $4.50; fixed costs, $5.04; and supervision, $1.64.

[c] Costs per crew hour for various categories are the same as in footnote b except that harvesting and packing labor is $33.57.

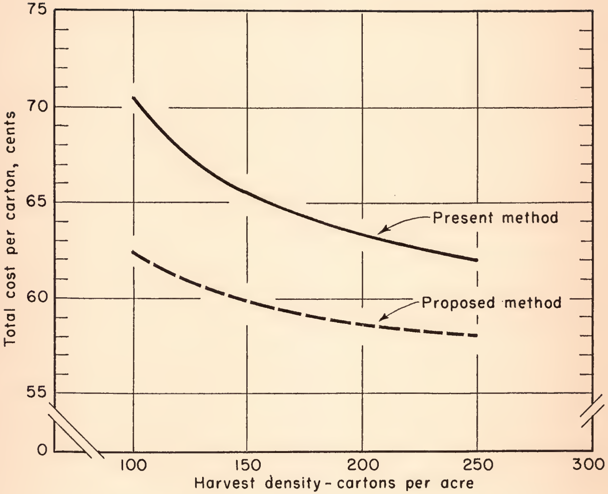

FIGURE 7. The Effect of Variation in Method and Harvest Density on Cost Per Carton for Field Packing Two-Dozen-Size Cartons of Lettuce, Using Machine-Pack Equipment in the Salinas-Watsonville Area, California, in 1953-54 (Excluding General Overhead Costs)

and packing labor costs per hour ($39.40 for the present method compared with $33.57 for the proposed method) reflects the net reduction of six men (the elimination of eight pickup men and the addition of two cutter-trimmers) with the proposed method.

The table indicates that unit costs would be less at all harvest densities with the proposed equipment than with the present machine method. Since unit costs decrease more rapidly with the present than with the proposed method as harvest density increases (see Figure 7), the cost difference between the two methods is greater with low than with high harvest densities. For example, at a harvest density of 200 cartons per acre, the costs per carton with the proposed method would be 4.7 cents ($30 per carload) less than with the present method. At a lower harvest density of 100 cartons per acre, cost per carton with the proposed method is 8.2 cents ($52 per carload) less than with the present method.

Even greater potential savings in cost are indicated when the proposed method is compared with the ground-pack method. At a harvest density of 200 cartons per acre, for example, the cost per carton with the proposed method would be 7.0 cents ($44 per carload) less than with the ground-pack method. At a low harvest density of 100 cartons per acre, the differences per carton would be 8.0 cents ($51.20 per carload).

While the above comparisons show substantial possibilities of cost reduction with the proposed method, the results hinge on the assumptions discussed earlier. These assumptions are believed to represent a reasonable extension of the data from studies of existing equipment, but their validity can be tested only by studies of operations incorporating the changes in method suggested.

APPENDIX

The basic data and calculations on which the preceding analysis rests are summarized in this appendix. These data include the unit labor requirements and capacity output rates on various jobs, a summary of allowances for nonproductive time in the various labor categories, production standards for hauling operations and estimates of replacement costs, annual fixed charges, and hourly operating expense for field-packing and hauling equipment. In addition, estimates of harvesting and packing labor cost per crew hour are given for the different methods studied. Crew costs per hour are based on the typical crew organization with each method shown in Tables 1 and 2.

The appendix includes the following tables. Details of the calculations are given in the footnotes to each table.

Table		Page
A	Unit Labor Requirements and Capacity Rate Per Hour for Various Field-Packing Operations--Hourly Rate Wage Plans	35
B	Unit Labor Requirements and Capacity Rate Per Man-Hour for Various Field-Packing Operations--Piece-Rate Wage Plans	37
C	Nonproductive Time Allowances for Three Methods of Field Packing With Both Hourly Rate and Piece-Rate Wage Plans	39
D	Production Standards for Hauling Operations for Three Methods of Field Packing, Salinas-Watsonville District, 1953-54	40
E	Harvesting and Packing Labor Costs Per Hour With Three Methods of Field Packing, Salinas-Watsonville District, 1953-54	42
F	Costs of Salaried Field Supervision With Three Methods of Field Packing, Salinas-Watsonville District, 1953-54	43
G	Estimates of Replacement Costs, Annual Fixed Charges, and Operating Expenses Per Hour for the Principal Equipment Units Used in Field Packing Western Head Lettuce, Salinas, Imperial, Yuma, and Phoenix Districts, 1953	44
H	Equipment Costs Per Field Hour for Three Methods of Field Packing, Salinas-Watsonville District, 1953-54	46

APPENDIX TABLE A

Unit Labor Requirements and Capacity Rate Per Hour for Various Field-Packing Operations--Hourly Rate Wage Plan

		Method								
		Ground pack			Machine pack			Trailer pack		
	Harvest density	Net time	Gross time[a]	Output per man-hour	Net time	Gross time[a]	Output per man-hour	Net time	Gross time[a]	Output per man-hour
		man-minutes per carton		cartons	man-minutes per carton		cartons	man-minutes per carton		cartons
Cut and trim	100	6.134	6.582	9.1	3.958	4.427	13.6	3.958	4.427	13.5
	150	5.703	6.111	9.8	3.506	3.864	15.5	3.506	3.864	15.5
	200	5.277	5.651	10.6	3.281	3.584	16.7	3.781	3.584	16.7
	250	4.846	5.154	11.6	3.145	3.416	17.6	3.145	3.416	17.6
Pack	100	3.072	3.388	17.7						
	150	2.819	3.092	19.4						
	200	2.567	2.810	21.4	1.236	1.545	38.8	1.236	1.545	38.8
	250	2.315	2.576	23.8						
Pickup	100				2.058	2.448	24.5	2.058	2.318	25.9
	150				1.762	2.034	29.5	1.762	1.947	30.8
	200				1.614	1.827	32.8	1.614	1.762	34.1
	250				1.525	1.703	35.2	1.525	1.650	36.4
Assemble carton										
Fold		.126	.140	429.0	.126	.140	429.0			
Stitch	[b]	.155	.172	349.0	.155	.172	349.0	.368	.409	147.0
Close carton										
Fold					.277	.325	184.0	.225	.265	226.4
Staple	[b]	.669	.787	76.2	.141	.165	363.0	.210	.247	242.9
Load				200.0[c]	.243	.270	222.0	.304	.338	178.0
Distribute carton				160.0[c]						

(Continued on next page.)

Appendix Table A continued.

a/ See Appendix Table C for nonproductive time allowances included in gross time.

b/ Production standards are unaffected by harvest density.

c/ Studies of this job were conducted in a way which did not permit separation of productive time from nonproductive time. Thus, only gross average time could be computed.

APPENDIX TABLE B

Unit Labor Requirements and Capacity Rate Per Man-Hour for Various Field-Packing Operations--Piece-Rate Wage Plan

		Method								
		Ground pack			Machine pack			Trailer pack		
	Harvest density	Net time	Gross time[a]	Output per man-hour	Net time	Gross time[a]	Output per man-hour	Net time	Gross time[a]	Output per man-hour
		man-minutes per carton		cartons	man-minutes per carton		cartons	man-minutes per carton		cartons
Cut and trim	100	3.112	3.530	16.9	3.001	3.356	17.9	3.001	3.356	17.9
	150				2.489	2.740	21.9	2.489	2.740	21.9
	200				2.234	2.434	24.6	2.234	2.434	24.6
	250				2.081	2.249	26.7	2.081	2.249	26.7
Pack	100	1.445	1.660	36.1	1.020	1.275	47.0	1.020	1.275	47.0
	150									
	200									
	250									
Pickup	100				1.317	1.553	38.6	1.317	1.553	38.6
	150				1.131	1.296	46.3	1.131	1.296	46.3
	200				1.038	1.168	51.4	1.038	1.168	51.4
	250				.982	1.090	55.0	.982	1.090	55.0
Assemble carton										
Fold	[b]	.098	.109	550.0	.098	.109	550.0			
Stitch		.098	.109	550.0	.098	.109	550.0	.242	.269	223.0
Close carton										
Fold	[b]				.194	.216	282.0	.186	.207	289.0
Staple		.555	.653	92.0	.114	.127	472.0	.213	.236	262.0
Load	[b]			282.0[c]	.200	.222	270.0	.274	.304	197.0
Distribute carton	[b]			248.0[c]						

(Continued on next page.)

Appendix Table B continued.

a/ See Appendix Table C for nonproductive time allowances included in gross time.

b/ Production standards are unaffected by harvest density.

c/ Studies of this job were conducted in a way that did not permit separation of productive time from nonproductive time. Thus, only gross average times could be computed.

APPENDIX TABLE C

Nonproductive Time Allowances for Three Methods of Field Packing With Both Hourly Rate and Piece-Rate Wage Plans

Job and wage plan	Turn-around time per strip			Delay and personal time		
	Ground pack	Machine pack	Trailer pack	Ground pack	Machine pack	Trailer pack
	minutes			per cent		
HOURLY RATE:						
Cutter-trimmers	2.0	2.0	2.0	5.0	5.0	5.0
Pickup	2.0	5.0	3.0	--	3.0	3.0
Packers	--	--	--	7.5	20.0	20.0
Carton assembling	--	--	--	10.0	10.0	10.0
Carton closing	--	--	--	15.0	10.0	10.0
Loading	--	--	--	--	10.0	10.0
PIECE RATE:						
Cutter-trimmers	5.6	2.0	2.0	8.0	3.0	3.0
Pickup	--	3.0	3.0		3.0	3.0
Packers	5.6	--	--	9.0	20.0	20.0
Carton assembling	--	--	--	10.0	10.0	10.0
Carton closing	--	--	--	15.0	10.0	10.0
Loading	--	--	--	--	10.0	10.0

APPENDIX TABLE D

Production Standards for Hauling Operations With Three Methods of Field Packing Salinas-Watsonville District, 1953-54[a]

Method of packing	Harvest density	Round-trip distance		
		10	20	30
		cartons per truck hour		
Hourly rate crew				
Ground pack	100	206	178	156
	150	206	178	156
	200	206	178	156
	250	206	178	156
Machine pack	100	134	121	111
	150	152	136	133
	200	163	144	130
	250	170	150	134
Trailer pack	100	83	78	74
	150	96	89	83
	200	102	95	88
	250	105	97	91
Piece-rate crews				
Ground pack		243	204	176
Machine pack	100	171	151	135
	150	192	167	148
	200	204	176	155
	250	204	176	155
Trailer pack	100	107	99	92
	150	124	113	104
	200	135	122	112
	250	142	128	116

(Continued on next page.)

Appendix Table D continued.

a/ Production standards include the following allowances:

For road time, waiting in the field, and unloading at the precooler per truckload:

45, 60, and 75 minutes at round-trip distances of 10, 20, and 30 miles, respectively, for all methods.

For loading time in the field:

Ground-pack, hourly rate--48 crew minutes per truckload. Since with the ground-pack method the hauling operation is not an integral part of the packing operation, loading time does not vary with harvest density.

Ground-pack, piece-rate crews--34 crew minutes per truckload.

Machine-pack, hourly rate--98, 81, 73, and 68 crew minutes per truckload for harvest densities of 100, 150, 200, and 250 cartons per acre, respectively. The loading operation with both machine and trailer crews is related directly to the output of the harvesting and packing crew.

Machine-pack, piece rate--67, 55, 49, and 49 crew minutes per truckload at harvest densities of 100, 150, 200, and 250 cartons per acre, respectively.

Trailer-pack, hourly rate--185, 156, 143, and 157 crew minutes per truckload at harvest densities of 100, 150, 200, and 250 cartons per acre respectively.

Trailer-pack, piece rate--134, 110, 97, and 90 crew minutes at harvest densities of 100, 150, 200, and 250, respectively.

APPENDIX TABLE E

Harvesting and Packing Labor Costs Per Hour With Three Methods of Field Packing
Salinas-Watsonville District, 1953-54

	Method														
	Hourly rate crews[a]						Piece-rate crews								
	Ground		Machine		Trailer		Ground			Machine			Trailer		
	Number of men	Crew cost per hour	Number of men	Crew cost per hour	Number of men	Crew cost per hour	Number of men	Piece rate per carton	Minimum crew cost per hour	Number of men	Piece rate per carton	Minimum crew cost per hour	Number of men	Piece rate per carton	Minimum crew cost per hour
		dollars		dollars		dollars		cents	dollars		cents	dollars		cents	dollars
Cut and trim	30	26.250	16	14.000	8	7.000	30	14.50	26.250	16	14.50	14.000	8	14.50	7.000
Bunch heads													2		1.750
Pick up heads			8	7.000	4	3.500				8		7.000	4		3.500
Pack carton	15	13.125	8	7.000	4	3.500	14		12.250	8		7.000	4		3.500
Distribute empty carton	2	1.750					2		1.750						
Fold packed carton top			2	1.750	1	.875				2		1.750	1		.875
Close and staple carton	4	3.500	1	1.575	1	1.575	6		5.250	1	01.25	1.575	1	01.25	1.575
Fold empty carton	1	.875	1	.875			1	01.25	1.575	1	01.25	1.575			
Stitch empty carton	1	1.575	1	1.575	1	1.575	1		1.575	1		1.575	1	01.25	1.575
Load flat-bed truck	4	3.500	2	1.750	1	.875	4	02.00	3.500	2	01.00	1.750	1	01.00	.875
Row boss	2	2.150	1	1.075	1	1.075	2	01.67	2.150	1	00.84	1.075	1	00.84	1.075
Total															
Net		52.73		36.60		19.98		19.42	54.30		18.84	37.30		18.84	21.73
Including pay roll taxes and camp costs		58.30		39.40		21.92		20.82	59.96		19.84	41.04		20.20	23.86

[a] The following shows the wage rates paid hourly rate crews in the Salinas-Watsonville district: row boss--$1.075; cutter-trimmers, packers, carton distributors, carton closers (ground pack), empty carton folders, packed carton folders (machine pack), and loaders--$0.875; and carton stitchers and carton closers (machine pack)--$1.575. To cover camp costs for Mexican National labor, 11 per cent was added to costs of wages listed at the rate of 87.5 cents per hour. Five per cent was added to the costs of wages listed at other rates to cover social security and workmen's compensation taxes for local employees.

APPENDIX TABLE F

Costs of Salaried Field Supervision With Three Methods of Field Packing Salinas-Watsonville District, 1953-54[a]

	Method					
	Ground pack		Machine Pack		Trailer pack	
Job	Number of men	Cost per hour	Number of men	Cost per hour	Number of men	Cost per hour
Supervision						
Net	1	3.125	½[b]	1.563	½[b]	1.563
Including payroll taxes		3.28		1.64		1.64

[a] Based on an average weekly salary of $125 and a 40-hour work week.

[b] The one-half man allocation to the machine and trailer methods indicates the division of time between two units.

APPENDIX TABLE G

Estimates of Replacement Costs, Annual Fixed Charges, and Operating Expenses Per Hour for the Principal Equipment Units Used in Field Packing Western Head Lettuce, Salinas, Imperial, Yuma, and Phoenix Districts, 1953[a]

Item	Stitcher	Hand tools for ground pack	Truck, flat bed-wide tread	Trailer-pack unit	Machine-pack unit
	dollars				
Replacement cost, 1953	500.00	500.00	7,600.00	1,700.00[b]	15,000.00[b]
Annual charges:					
Depreciation[c]	62.00	100.00	950.00	212.00	1,875.00
Tax and license fees	5.00	5.00	153.00	37.00	305.00
Insurance	8.00	8.00	75.00	13.00	90.00
Interest on investment[d]	15.00	15.00	228.00	51.00	450.00
Fixed repair[a]	15.00	15.00	228.00	51.00	450.00
Total	105.00	143.00	1,634.00	364.00	3,170.00
Cost per hour with 1,280 hours of use per season	.08	.11	1.28	.28	2.48
Cost per hour with 720 hours of use per season	.14	.20	2.27	.51	4.40
Operating costs per hour (excluding labor)					
Gasoline	.04		.48	.04	.50
Oil	—	—	.05	—	.10
Tires	—	—	.19	—	.06
Repair and miscellaneous[f]	.04	—	.60	.14	1.20
Total	.08		1.32	.18	1.86
Total equipment cost per hour with 1,280 hours of operation[a]	.16	.11	2.60	.46	4.34
Total equipment cost per hour with 720 hours of operation[a]	.22	.20	3.59	.69	6.26

(Continued on next page.)

Appendix Table G continued.

a/ Costs per hour in the Salinas district are based on a 1,280-hour season. Costs per hour for Imperial, Yuma, and Phoenix districts are based on a 720-hour season.

b/ Includes costs of all accessories. Newer models, functionally equivalent to the equipment priced above, are available for $10,000.

c/ Estimated on basis of eight-year use life, with no salvage value at end of use period.

d/ Approximately 5.0 per cent on undepreciated balance of investment.

e/ Estimated as 3.0 per cent of replacement cost.

f/ Estimated as 0.8 per cent of replacement cost per 100 hours of use.

APPENDIX TABLE H

Equipment Costs Per Field Hour for Three Methods of Field Packing Salinas-Watsonville District, 1953-54[a]

Cost category and type of equipment	Method					
	Ground		Machine		Trailer	
	Number of men	Cost per hour	Number of men	Cost per hour	Number of men	Cost per hour
Operating labor[b]						
Stitcher truck	1.25[c]	1.856				
Packing machine			1.25[c]	1.856		
Highway trucks	2[d]	3.300	2	3.300	2	3.300
Net		5.16		5.16		3.30
Including payroll taxes		5.41		5.41		3.47
Fuel, repair, and tires						
Stitcher truck and two stitchers	1	1.440				
Highway trucks	2[e]	2.640	2	2.640	2	2.640
Packing machine			1	1.860		
Trailer					1	.180
Total		4.12		4.50		2.82
Fixed Costs[f]						
Stitcher truck and two stitchers	1	1.440				
Highway trucks	2[g]	2.560	2	2.560	2	2.560
Packing machine			1	2.480		
Trailers					2	.560
Hand tools		.110				
Total		4.11		5.04		3.12

a/ Based on crew sizes described in Tables 1 and 2 and used in calculation of labor cost per crew hour.

b/ All drivers are paid at the rate of $1.65 per hour.

c/ Includes an allowance of 12.5 per cent for highway travel to and from the field.

d/ With the ground-pack method using a piece-rate wage plan, estimates are based on the use of three trucks for 6.8 hours per day or 2.5 truck hours per crew hour for crews working an 8-hour day. This raises the cost of highway truck drivers to $4.125 and the total operating labor cost to $6.28 per field hour.

e/ With the ground-pack method using a piece-rate wage plan, the use of an additional highway truck raises fuel, repair, and tire costs for highway trucks to $3.300, and the total cost of fuel, repair, and tires is $4.780 per field hour.

f/ Based on a 1,280-hour operating season.

g/ With the ground-pack method using a piece-rate wage plan, use of an additional highway truck raises fixed costs for highway trucks to $3.20 per hour and total fixed costs to $4.25 per hour.